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HOTRES: renewable energies in the hotels. An extensive technical tool for the hotel industry

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Abstract

The project HOTRES aimed at the systematic implementation of conditions for future massive applications of the renewable energies in the tourism industry. Under the umbrella of this project five renewable energy technologies were promoted (solar thermal, solar passive, solar PV, biomass

Abbreviations: ADEME, Agence de l'Environnement et de la Maitrise de l' Energie; AMG, Azienda Municipale Gas; AREAM, Agenzia Regional da Energia e Ambiente da Regiao Autonoma da Madeira; BEMS, building energy management system; CRES, Centre for Renewable Energy Sources; DGTREN, Directorate General for Energy and Transport; DHW, domestic hot water; EGEC, European Geothermal Energy Council; EPIA, European Photovoltaic Industry Association; ES, energy saving; ESD, executive design sheet; ESTIF, European Solar Thermal Industry Federation; EU, European Union; EUBIA, European Biomass Industry Association; HVAC, heating, ventilation, air-conditioning; MA, Manufacturer Association; OPE, operational programme for energy; PV, photovoltaic; RES, renewable energy sources; RET, renewable energy technologies; RUE, rational use of energy; SHW, solar hot water; SME, small and medium enterprises; SODEAN, Sociedad para el Desarollo Energetico de Andalucia; TUC, Technical University of Athens.

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and geothermal energy) in parallel in five EU regions (East Attica, Sicily, Alpes-Maritimes, Andalusia and Madeira) by the corresponding agencies and promotion centers following an extensive and intensive work program be composed of six elaboration phases. The purpose of this article is to esteem the results achieved in the technical–economic field of the relevant extensive technical support project in 200 hotels as well as to validate the strategic methodology applied for the promotion of the renewable energy technologies (RETs) through the technical assistance of the hotel SMEs. Finally, by proving the liability and economic viability of RET applications in hotels, the largest European hotel installation with solar thermal is presented within technical and economic details.

Keywords: Renewable energy; Tourism; Hotel; Environment; Solar thermal energy; Geothermal energy; Photovoltaic; Biomass; Solar passive

Contents

1. Introduction

The tourism industry is amongst the most dynamic areas within the services sector, this being especially the case in the Southern Europe (France, Greece, Italy, Spain and Portugal). In all these countries the tourism sector is an essential development tool (i.e. in 2000 the tourism industry is deputing the 16.3% of the Greek Gross Domestic Product and represents the most important service industry [1]).

Recently, in national level, EU and international tourist policy are aiming at the improvement of the existing infrastructure, the lengthening of the operation season, the improvement of alternative forms of tourism (i.e. eco-tourism, health tourism etc.) but, always minding environment [2]. As regards energy consumption in hotels, challenged represented, that is competitiveness, the importance of reducing cost and growing sensitivity to environmental factors in hotel design, which is leading to the introduction of elements with less environmental impact, all combine to create conditions favourable to the optimization of energy resources and the introduction of RETs.

Nowadays, EU strongly encourages the environmental performance of services and products. Additionally the public awareness and the demand of the tourism product continuously require more environmental friendly services. The implementation of RET projects in current hotel units shall give them a comparative advantage of environmental performance. Considering any forthcoming EU eco-labeling scheme in the hotel sector, any RET application would be considered a surplus advantage for hoteliers to participate in. Even though RET applications would not be involved in any mandatory approval criteria for an eco-management scheme, surely they would be accepted as the first step on a positive environmental image and marketing efficiency of an enterprise.

In conclusion, in order to promote RETs to the tourism sector effectively, isolated promotional activities are not sufficient. A new methodology should be worked out in order to take the interested party by hand, through all the stages leading up to the implementation of the system in the sector. This is particularly relevant in the hotel sector where you meet poor technically oriented staff, and you have to drain out who can receive information on RETs and their applications and then follow the subject of their installation themselves according to their technical knowledge.

2. Energy related topics of the hotel sector

In the relevant energy topics of the hotel sector, particular in the south EU, we can note down the following particularities and weaknesses:

- The majority of the units are approximately sized 100 beds (this means a 'Mediterranean' type, family type enterprise). These SMEs focus at providing

the highest level of services in their facility, so they have no awareness about 'how energy is produced', in order to require technical assistance.

- Many hoteliers are willing to invest in renovation, so they welcome the concept of introducing RETs, due to the social status and the marketing argument, regarding the forthcoming requirements for the ecolabeling of their hotel units [3].
- Investment funds are not the core problem for the low profile of the RES penetration in the sector, since future investors have sufficient budgets for renovation and environmental-profile works [4].
- There is an extremely low degree of RET penetration in the sector, solar active excluded [3]. For instance, in a statistical sample of 32 Greek hotels spread out with equivalent statistical frequencies over the country's regions and over the various hotel categories only 2 units have been found using RET, other than solar active (Fig. 1).

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Nevertheless, the solar active 'penetration' is satisfactory (8 plants on 32 hotel units), but still there is work to be done for target-regions other than Greece which are extremely weak (these target regions selected for the applying the strategic methodology through the HOTRES project are Sicily, Madeira, Andalusia and Cote d'Ajur/Alpes Maritimes).

There is lack of experienced engineers, to support and promote energy projects to the hotel management, follow up the project and maintenance to the highest level of operation [5].

Moreover, when the liable of each hotel is interested in a specific RET, asks for an application for his enterprise, limited information is available about suppliers, manufacturing companies, third parties independents (with no partiality) about the use and results of these technologies, etc.

According to the experience of the participants of the project, the reasons for the above extremely low profile scheme of RETs penetration in the hotel sector, find their source in three market weaknesses:

(i) Investment fund shortage

As it is obvious this is rather important [4].

(ii) Low feasibility, viability and quality of products

This subject is also essential, since numerous installations in all the South EU territory

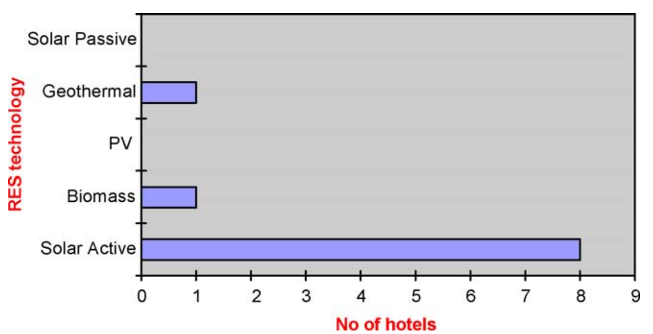


Fig. 1. Penetration degree of RET in a 32-hotel statistical sample in Greece [2].

covered a part of their energy needs by using of feasible, viable and good quality RET. For example in Greece over 800 hotel units (totally 7.000 units) use solar active.

(iii) The lack of information and follow up

This seems to be the most crucial parameter.

Therefore, there is an obvious need to guide the potential investors of the tourism industry through the following steps:

- Presentation of the regional market need and availability of RETs addressed to the tourism sector
- Presentation of the RETs and successful hotel case studies in a simple, easy to follow, but thorough technology support tools
- Performance of a ‘quick selection’ basic design of a technology in order to convince the decision makers of the applicability of the system and arrange for them a visit in one of an existing hotel with successful installation
- Arrangement of business meetings between the suppliers and hoteliers as prospective investors
- Provision of support for pilot projects

3. Development of a conceptual methodology to be tested in the hotel sector

Considering both, the present existing situation in the hotels and the environmental performance in the sector, as remarked in the previous paragraph, an innovative approach of the sector SMEs for the design of a specific action should aim at the:

(i) Formulation and implementation of a strategic methodology for the promotion of RETs

The core aspect of this methodology is the concentration on the implementation of conditions for the future expansion of these technologies in the hotel sector. This will be done mainly business oriented on a regional level (East Attica, Alpes Maritimes, Sicily, Madeira, Andalusia) by the corresponding agencies (CRES, ADEME, AMG, AREAM, SODEAN) in collaboration with equipment manufacturing associations and will be based on the experience acquired within previous advanced projects (i.e. in Catalonia).

(ii) It will promote the implementation of solar active installations with highlights on innovative technologies

Solar active installations have already known technological development in the tourism sector of certain countries (i.e. hotels in Spain and Greece) or in similar users [6] to other regions of European countries with little or no applications of these systems (e.g. Madeira, Portugal). Solar cooling technologies in hotels seem an excellent challenge for hotel managers to show the use of innovative and cost effective technologies [7] with highly positive environmental impact.

(iii) The involvement of five regions from five countries and their local business actors

The involvement of local business actors has being considered as really necessary, for example: (i) Local owners of tourism and leisure facilities; (ii) Suppliers and manufacturers of RETs; and (iii) Local engineers and technicians, as partners in developing the use and application of RET in the tourism and leisure industry assisting the

penetration of these technologies easier, helping the local market development. This is particularly important for local market strategies [8].

Following this conceptual approach, a number of specific actions as well as the respective tools for the technical support to the hoteliers have been developed and extendedly depicted in the next paragraph.

4. Project monitoring and evaluation

The project specific actions were [9]:

4.1. Action 1: market survey

Main activities:

- Regional market survey of the energy requirements of the tourism industry
- Locate and list suppliers of RETs geared towards the tourism industry
- Monitoring of five different technologies in five regions over a 3-month period.

The tool produced is a market assessment including:

- Five regional market surveys of the energy related equipment in the tourism industry (Madeira, Andalucia, Sicily, East Attica, Alpes Maritimes)
- A hotel-oriented assessment study of existing suppliers of RES technologies (biomass, photovoltaic and geothermal, active and passive solar) and a hotel-oriented technology assessment study of these technologies
- Evaluation and monitoring of five existing projects (in the above five regions) relevant to five different RETs.

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4.2. Action 2: tools for technical assistance

An executive type, business oriented folder was produced and consisted of ten double sided leaflets. The leaflets were produced with a market-oriented technique and covered five sectors (geothermal, photovoltaic, biomass, active and passive solar). The folder was translated into Greek, Italian, Portuguese, Spanish and French.

For a preliminary basic design of the system 10 Executive Design Sheets (ESDs) were also elaborated. Main contents: type of technology proposed, area and volume required for the installation of the equipment, investment required, energy savings, CO_2 emission reductions.

The tool produced is a folder which is used for promotion during 200 door-to-door presentations (40 for each region) and the ten executive design calculation sheets.

4.3. Action 3: technical assistance and follow-up

The pre-feasibility studies and site visits including:

- Fifty hotels (10 hotels per region) that have participated in order to have the ESD of the chosen (by them) specific RET applied to their case study.
- Twenty-five hotels (five hotels per region) that have asked the local agency-partner to organize a visit to an existing installation in another hotel of the region or country.

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4.4. Action 4: sectorial business meetings

Five regional workshops (one workshop per region) have been organized in which all five RETs under promotion were presented. The manufacturing associations (ESIF, EPIA, EUBIA, EGEC), who are suppliers and construction companies, have presented to the audience, consisted mainly of hotel owners and managers, their existing projects in the hotel sector; as well as their technologies, their products and any related maintenance and installation requirements.

The product produced was the promotion effect during these five regional workshops.

4.5. Action 5: support to pilot projects

In order to stimulate and encourage joint efforts, a technical support was given to one joint project per region/country target. The allocated amount is considered to cover a fully developed technical study for the application of the RET selected as well as to cover accompanying costs such as contractual support, technical consultancy to the hotel concerned, elaboration of their market surveys prior to the arrangement and two reciprocal travel, when needed, for technical assistance and training.

5. Results: information given by the hotel personnel

During the informative visits made to the personnel of the 200 (in total) hotel establishments, the following queries on the acceptance of RES were asked to the hotel managers:

- To rank the importance of RES introduction at a hotel;
- To describe whether RES investments will be achieved the next five years, at the hotel;
- What is the perceived knowledge on RES subjects by the company’s personnel;
- To give some statements about RES in a modern hotel organization;
- To recommend possible future investments.

. The following Figs. 2–4 show the results of the answers to the first three questions, since the last two questions were not always answered.

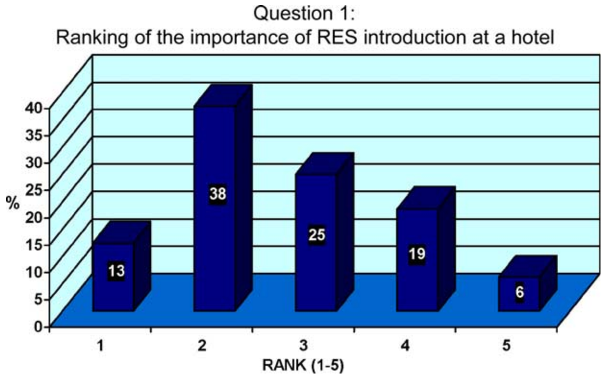


Fig. 2. Performance of RET, when the hotel personnel of 200 hotels in the EU is asked.

6. Assessment of the hotel sector reaction against RET promotion

The effect prevailed upon, after auditing 200 hotel units are of two types:

1. *Techical–economic related*: in order to prove that the RET in the hotels have today reached a high level of technological maturity and a reasonable degree of economic liability, 50 hotels of the 200 units been audited, have been assessed with software of prediagnostic type regarding the technical–economic viability of the technology selected for possible future installation with the purpose to stimulate hotel managers *in decision making*.Furthermore, monitoring studies in eight hotel units through the five regions involved and covering five RETs (solar thermal, solar passive, solar photovoltaic, geothermal energy and biomass systems) have been carried out with the purpose to prove the *liability of the systems and their energy efficiency* to the potential investors—hotel managers.Moreover, basic designs in six hotel units through the five regions involved and covering the technology suggested by the hotel owner among

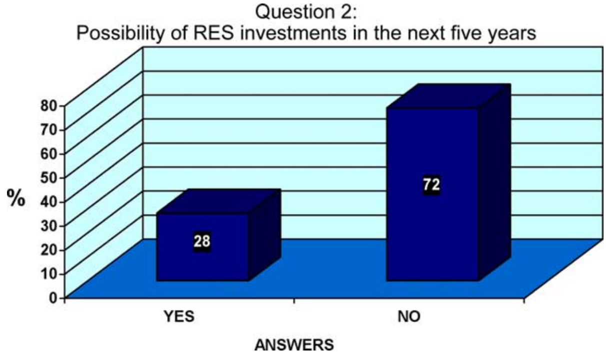


Fig. 3. Investment opportunities for RET in 200 hotels in the EU.

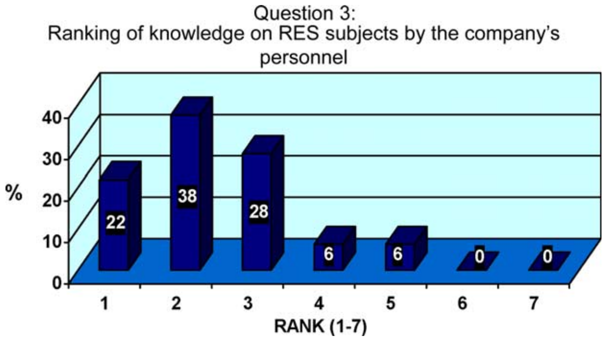


Fig. 4. Level of knowledge of RET by the personnel of 200 hotels in the EU

the five ones under promotion, have been carried out with the purpose to support future pilot project and achieve *best-practice installations*.

2. *Marketing related*: Since the tourism market meets large variety of peculiarities through out the five regions involved in the project, it has been considered that an effective way in presenting the impact assessment of the *HOTRES action plan* and its conceptual promotion methodology, is to make a geographical display of conclusions along each region.

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6.1. Technical–economic related results: the Executive Sheet Designs (ESD)

It is useful and statistically representative to evaluate the results from 50 hotel units (among the 200 units been audited door-to-door), which asked the local agency-partner in order to have the ESD of the chosen by them specific RET applied to their case study.

A quick audit at the hotel was made in order to collect the various parameters required by the ESDs to obtain reliable results.

In summary, the RETs been applied in these 50 hotel units, are depicted in Table 1.

The fifty pre-diagnostic studies, based on the ten software environments, suggested to the hotel managers various technical solutions using RETs and gave to them the needed information in order to be in a position to decide for a basic design and a future RET project.

Table 1
Type of RETs applied in 50 hotel units in the EU

Country	Body	Bio system	Geo system	Passive system	PV system	Thermal solar system	Total
Greece	CRES		5		1	8	14
Andalusia	SODEAN				4	4	8
Sicily	AMG				5	5	10
Madeira	AREAM					10	10
France	ADEME					8	8
Total		0	5	0	10	35	50

In Table 2 we give the results of the above-mentioned evaluation for the whole hotel sample spread out in the five targeted regions in terms of the relevant RET, size of equipment and pay back period, as an indicator of the market interest to the respective RET application. The allocation of type of equipment down to the number of 51 hotel units in the EU who have chosen this RET is depicted in the Fig. 5.

The results given in Table 2 are based on real economic and financial conditions existing in the targeted regions as shown in Table 3 in terms of equipment cost, type and cost of fuel displaced, cost of electricity, as well as the rate of subsidization taken into account.

It is interesting to realize that solar thermal is the technology the most sought (66% of the feasibility studies been asked by hotel managers, Fig. 5).

It is also impressive to notice, when examining the results shown in the Table 2, the following geographical deviations, marked:

1. Solar thermal present same economic results in Greece, Andalusia and Sicily. But in Madeira the pay back period rises to double and in France up to be tripled.
2. PV in Sicily and Greece present same results, while in Andalusia the pay back period decreases down to the half. No preferences reported for PV in the hotels in France and in Madeira.
3. Only one solar cooling study is shown in a hotel in Greece.
4. No preferences at all reported for biomass and bioclimatic systems in the hotels in all five regions of the EU.

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The above-mentioned geographical deviations are easily understood when taking into consideration the economic data displayed in the Table 3, were differences have been noted from one region to another.

Appendix shows operational and econimic data from a large solar plant in a hotel unit in Greece. (according to this case study, pay back period is found equal to 4.1 years).

6.2. Marketing related results: the impact assessment

It has been considered that an effective way in presenting the impact assessment of the *HOTRES action plan* and its promotion methodology is to make a geographical display of conclusions along each region instead of making a mixing of the areas, building a South-European 'mean' figure.

The assessment is consisting by two major evaluations:

- *Positive impact assessment*—an assessment of the positive feedback received from the investors in the promotional activities of the project (i.e. energy savings, reduction of air pollution, 'green' image of hotel).
- *Obstacle assessment*—an assessment of the obstacles that had to be overcome in the promotion of the RET products (i.e. lack of investment funds by investors, reluctance to

Table 2
Pre-feasibility studies with to Renewable Energy Technologies (RET) elaborated in the framework of the HOTRES project

Name of hotel	Renewable energy technologies examined							Number of pre-feasibility studies
	Place	Biomass	Solar passive	Geo-thermal	Solar PV	Solar SHW	Solar cooling	
Greece								
Porto Valitsa	Chalkidiki			46 kW 3.9 years		30 m^2 3.1 years		2
Metropolitan	Corfu				1.67 kWp 43 years	600 m^2 5.1 years		2
Lutania Beach	Rhodos	525 kW 4.3 years				600 m^2 4.4 years	601 m^2 8.0 years	3
Casino Rhodos	Rhodos			30 kW 4.6 years				1
Colossos Beach	Rhodos			1751 kW 4.7 years		200 m^2 1.7 years		2
Kresten Palace	Rhodos			1050 kW 4.3 years		400 m^2 3.3 years		2
Marie Hotel	Rhodos				1.38 kWp 39 years	60 m^2 2.2 years		2
Total in Greece				5	2	6	1	14
Andalusia								
Parador Hotel Atlántico	Cádiz				6 kWp 7 years	192 m^2 3.4 years		2
Hotel San Gabriel	Ronda (Málaga)				6 kWp 7 years	20 m^2 7.7 years		2
Hotel Tartessos	Huelva				6 kWp 6.5 years	40 m^2 4.2 years		2
Hotel Villas de Antikaria	Antequera (Málaga)				6 kWp 9 years	320 m^2 3.5 years		2
Hotel Molino las Pilas					6 kWp 9 years			1
Total in Andalusia					5	4		9

Sicily					
Addaura	Palermo		40 m^2 4 years		1
Città del Mare	Terrasini		500 m^2 5 years		1
La Torre	Mondello		100 m^2 3.5 years		1
Politeama	Palermo		40 m^2 4 years		1
Saracen	Capaci		130 m^2 4 years		1
Atheneum	Palermo	10 kWp 38 years			1
Conchiglia d'oro	Mondello	20 kWp 38 years			1
Cavour	Palermo	5 kWp 38 years			1
Sirenetta	Isola d. Femmine	20 kWp 38 years			1
Torre Artale	Trabia	8 kWp 38 years			1
Total in Sicily			5	5	10
Madeira					
Pensão Vila Vicência	Funchal		39 m^2 8 years		1
Hotel Madeira Carlton I	Funchal		95.3 m^2 9 years		1
Hotel Madeira Carlton II	Funchal		138.33 m^2 9 years		1
Village Hotel	Funchal		62.4 m^2 8 years		1
Hotel Atlantic Gardens	Funchal		82.2 m^2 8 years		1
Pestana Miramar Hotel	Funchal		69.2 m^2 8 years		1
Dom Pedro Garajau I	Caniço		79 m^2 7 years		1
Estalgem Q. Rochinha I	Ponta de Sol		20.8 m^2 7 years		1
Dom Pedro Garajau II	Caniço		46.4 m^2 9 years		1
Estalagem Q. Rochinha	Ponta do sol		71.3 m^2 7 years		1
Total in Madeira			10		10
France					
Le Prieuré–Les Molanes	Pra-Loup		28 m^2		1
Chrisma	Laragne		24 m^2 15 years (gas substituted)		1

Table 2 (*continued*)

Name of hotel	Renewable energy technologies examined							Number of pre-feasibility studies
	Place	Biomass	Solar passive	Geo-thermal	Solar PV	Solar SHW	Solar cooling	
Les Anémones	Marseille					140 m^2 19 years (gas substituted)		1
Le Roc	Antibes					60 m^2 12 years (electricity substituted)		1
Le Val Fleuri	Cagnes sur Mer					53 m^2 18 years (electricity substituted		1
Hostellerie du Vallon de Valrugues	St Remy de Provence					60 m^2 11 years (gas substituted)		1
Les Belles Terrasses	Tourettes sur Loup					42 m^2 10 years (fuel oil substi-tuted)		1
Base nautique	Embrun					17 m^2 16 years (electricity substituted)		1
Total in France						8		8
Total in all the five countries (Greece, Andalusia, Sicily, Madeira, France)				5	12	33	1	51

Size of equipment and pay back period are shown.

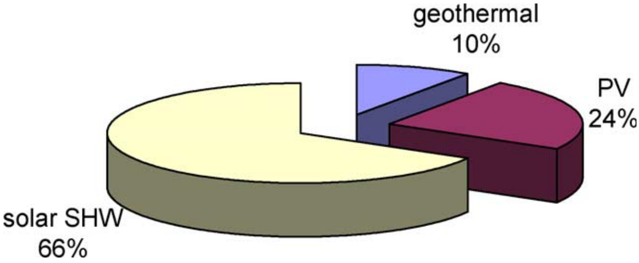


Fig. 5. Percentage of RET examined in the 51 pre-feasibility studies performed in 39 hotels in the EU.

try new technologies, deficiency of technical knowledge, previous bad experiences, failing of suppliers, cost of system).

6.2.1. Impact assessment in Attica, Greece

An important indicator of the assessment of the HOTRES project results has been the estimation of the attainment of the objectives of the project, by taking into consideration the relevant market audits, events, monitoring results of existing RES installations in the hotel sector and general information from the five regions involved in the elaboration of the work programmed.

Positive impact assessment for the Greek tourism sector.

The qualitative positive results obtained from the project monitoring are:

- the tourism sector runs yearly, with important investment programmes under the code name 'renovation works' and it is beneficial to relate the RETs to this code name, since the RETs offer to the enterprise an ecological image, often necessary to the hotel manager in order to compete with the upcoming and severe standards for environmental protection
- hotels are energy consuming enterprises and this is why RETs can be a viable solution in reducing energy consumption and energy cost; they can also promote local production of technologies (i.e. solar) and most important local development
- the strategic methodology of the project HOTRES seems to persuade the hotel managers, because the technologies under promotion are already demonstrated, in commercial scale and, most important, are in operation in hotels of their neighborhood or in their 'competitors' installations
- even if we meet a poor specimen of application with RES in locally taken hotel samples, while in other sectors RES perform a rich expansion experience (i.e. building sector), we have localized numerous hotel units with very satisfactory, energy related, operation
- many hoteliers are willing to invest in renovation projects and they welcome the idea of introducing RET, because it gives a social status and a strong marketing point, regarding the coming requirements for the ecological labeling of hotel units
- there is great need for the announcement of subsidy programmes, from the Local Authorities, which overall act as psychological incentive.

Table 3
Economic parameters hindering RES penetration in the Hotel sector

	Cost of equipment, including installation. (Taxes free)	Software used for calculations	Fuel displaced		Cost of electricity (displaced in cases of cooling, geoth, PV) (taxes free) €/kWh	Rate of subsidization for RES in hotels
			Type	Cost (taxes free) €/kWh PCI		
Greece	Solar thermal 320 €/m^2 PV grid connection 6.5 €/Wp Solar cooling 7337 €/RT Geothermal 645 €/kW	Tsol (Solar thermal) PVSYST 3.11 (PV) Solhot-cool (Solar cooling) Geohot (Geothermal)	Diesel 'motion'	0.065	0.065	Solar thermal 40% PV 45% Solar cooling 50%
Andalucia	Solar thermal 440–620 €/m^{2}PV grid connection 6–8 €/Wp	f-chart (Solar thermal)	Natural gas Diesel oil LPG	0.026 0.029–0.033 0.042-0.049	0.066–0.096	Solar thermal 30–45% PV 50–60% *Comments:* Sale prices of the electricity generated with PV panels: 0.22 €/kWh (PV Installations > 5 kW) 0.40 €/kWh (PV Installations <5 kW)
Sicily	Solar thermal 500 €/m^2 PV grid connected: 6, 5 €/Wp	f-chart (Solar thermal)	Natural gas Diesel oil	0.054 0.070	0.12	40% 40–50%
Madeira	Solar thermal 500 €/m^2	SolTerm	Propane	0.06	0.104	35–40%
France	Solar thermal 650–800 €/m^2	Solo	Gas Fuel oil	0.04 € 0.037 €	 0.11	40–50%

(ii) Negative impact assessment for the Greek tourism sector.

In the Greek tourism sector and more specifically in the hotel sector, regarding the energy related topics, exist the following particularities and weaknesses have been noted:

- The majority of the hotel units are SMEs and they are sized approximately around 100 beds (this means a 'Mediterranean' type, family centered enterprise). These SMEs aimed to prove the highest level of services in their facility, and have no awareness about 'how energy is produced', so, they need technical assistance for that.
- Consequently, it seems that there is no efficiency of full-time engineers, which are expected to implement energy projects, promote them to the hotel authority, follow their manufacturing and maintenance of the project, keeping them to the highest level of operation,.
- There is an extremely low number of RET applications in the hotel sector.

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6.2.2. Impact assessment in Alpes-Maritimes, France

Forty-eight hotel-managers of the Provence-Alpes-Côte-d'Azur region were assessed. All these persons were interested mainly in solar thermal applications.

Forty hotel-managers filled a visit sheet.

Eight hotel-managers answered to a detailed questionnaire.

Results from the impact analysis allow us understanding that.

The impact varies from one area to another. The analysis of the number of hotel-managers shows clearly a difference in term of involvement relative to RES development, from one area to another. Alpine and mountainous areas are far more involved than coastal areas, unless they profit from the best sunshine of all the country (more than 5.2 kWh/m^2/day).

The type of equipment depends on the type of hotel/tourist structure. It seems that most motivated managers are managers of camping-sites. Their operating period perfectly fit to the sunniest period (April–October). The commercial concern seems to be more important than the environmental one.

(i) Positive impact assessment for the French tourism sector.

Numerous projects are in progress. The results of the survey are very positive:

Eight percent of the hotel studied already realized what a solar installation is,.

Thirty-eight percent are doing so (of which half have already done the pre-diagnostic studies).

Some of the projects-managers are waiting for their loan/subsidies agreement and the installations should be implemented in the following months.

Only 3 projects have been abandoned, of which one without any reason, one because of a poor sunshine (the hotel is mainly shaded) and a last one is postponed.

(ii) Negative impact assessment for the French tourism sector.

Poor concern for RES is noticed within the hotel–tourist field; it seems that hotel-managers of the coast area have poor concern for RES. Managers of the other areas of

the region seemed more motivated but generally, hotel-managers seemed to be poorly interested and concerned.

The interest to invest in the RES is low k but needs to be developed through information campaigns; 66% of the managers who answered the questionnaire wish to renew their investment in RES (that is more than 2 on 3!). This result is encouraging.

Thus, information campaigns should be organized to develop and expand this interest.

Knowledge of the persons relative to the RES is poor. Only two managers feel confident with RETs and defined themselves as 'expert'. The majority of the persons have idea of the technical matters and technologies used.

Twenty-three percent of the persons contacted said that they do not know what it is about, at all.

It seems that only the manager of the hotel, in charge of the project, is informed of the technologies.

Knowledge of existing solar installations in the hotel sector. Generally speaking, knowledge of the hotel-managers in term of existing solar installations is poor. 4 out of the 5 managers are unable to give any example of an existing installation. Usually, the example given is related to bad impressions (the installation is old, not working, working badly).

6.2.3. Impact assessment in Andalusia, Spain

During more than 30 informative visits made to hotel establishments in Andalusia, a series of aspects relating to the qualitative impressions of these with respect to the possibility of the use of RES in the hotels of the region have been detected.

Within the RES proposal, some of them are conditioned by the climate and geographic conditions of our region. Due to this, some of the RES are discarding, for example, geothermal, in benefit of others, such as solar energy.

It should be commented that geothermal energy is not used due to the difficulty of finding geothermal wells close to urban centers and biomass presents a series of problems for the hotel responsible due to the lack of nearby suppliers, the need for storage and the difficulty that these are seen in a direct relationship with the 'green image' caused partly by the emissions of smoke.

In addition to these reasons, a special interest in solar energy in comparison to others has been identified, due to the current existing implementation in the hotel sector and its greater knowledge. This is caused, among other reasons, mainly by the promotion and the existence of subsidies to applications of solar energy in Andalusia. It is for this reason that this study finally focused on the promotion of solar energy as a RES for its use in the hotels of the region. The decision makers of the sector showed a greater interest for active solar systems, especially solar thermal for hot sanitary water and solar photovoltaic.

(i) Positive impact assessment for the Spanish tourism sector.

The members of the sector, interviewed in Andalusia, showed really great interest in using solar energy systems in their hotel establishments.

Among other positive aspects emphasized by the hotels contacted, the *saving in fuel consumption and* in consequence, the energy saving, that is possible to obtain from the installation of these systems.

Another positive point that should be indicated is the good acceptance of the whole idea due to the existence of *subsidies* for the installation of solar thermal systems of hot sanitary

water and photovoltaics, both stand-alone as well as connected to the grid that reduces the initial investment of the installation of these systems. It should also be noted that some hotels that have received some type of subsidy complain of the time and administrative steps that they have had to follow when requesting these subsidies.

The importance that the hotel responsible of these establishments granted to the *environmental image* has been observed; particularly, from those which their clients looking for of an ecological tourism. In any case, a huge part of tourism in Andalusia comes from central and northern Europe where there is greater awareness of the environment. In this sense, the hotel establishments that use RES are favored by this tourism.

Finally, in rural type lodgings, located in *natural spaces* away from conventional energy sources, it is positively valued the autonomy, from the energy point of view, that these types of installations offer, the saving that is introduced in transport and fuel consumption and the ecological image in accordance with the philosophy of tourism that goes to these natural spaces.

(ii) Negative impact assessment for the Spanish tourism sector.

The main obstacles to the implementation and use of RES in the hotel sector, indicated by the responsible of the sector, are the following.

It emphasizes the high *initial investment* that is needed for undertaking the equipping of this type of installation. It seems, however, that it is smoothed by the subsidies to which reference has been made previously, and each time offers fewer obstacles at the time of the introduction of these energies.

Another important obstacle is in the *organizational structure* of the hotel sector in Andalusia. Many of the hotel establishments of our region belong to great chains of trans national or multinational character or the managers of these hotels deprived the power to undertake, independently, the investments in RES systems. Specifically, 20% of the hotels surveyed belong to hotel chains.

The difficulty of the *architectural integration* and the possible visual impact, in some cases, is an impediment in which the active solar systems are found. Some of the hotels visited are located in historical areas of cities and sometimes even the hotels are historical buildings and, therefore, have to adapt to the regulation requirements that make the installation of solar collectors, thermal or photovoltaic, difficult.

Currently the existence of *subsidies* is reclamation in the hotel sector for the installation of solar energy systems in these establishments, but the slowness and difficulties of the bureaucratic procedures that are necessary for its concession, can bring about the contrary effect: refusing to request for the subsidy. This elevates the initial investment necessary, and can cause the renunciation of installing the solar system.

Certain *distrust* in the effectiveness and reliability of the RES has also been detected. This distrust is due to the ignorance of the technology and to past negative experiences with badly designed or inadequately maintained installations. It seems that this problem is being surpassed with the installations made during recent years, which work correctly.

It is important to indicate, in this sense, that new procedures for the use of these energies are currently rising which would reduce this problem, like the sale of energy, the development of contracts from guaranteed solar results, etc.

6.2.4. Impact assessment in Madeira, Portugal

(i) Positive Impact Assessment for the Madeira tourism sector.

The project had an important role, specially, concerning the results of the monitoring done to the solar thermal system, to clear the image of this type of solar systems, because during many years, this technology had very bad results due to the lack of knowledge in how and where to implement the solar systems.

The distribution of the folder, and the meetings held between AREAM and the hotel managers, contributed greatly to enhance the idea of the 'green' image and social awareness image of the enterprises to the general public and possibly to increase their market value.

It also, showed to the hotel managers, how these technologies could aid them in introducing environmental management schemes, where energy and money can be saved and avoid pollution simultaneously.

(ii) Negative impact assessment for the Madeira tourism sector.

The main obstacle was the international situation of the tourism market. The potential investors are not very favourable to make additional investments, not being sure of the development of the international situation in short-term.

Many investors are still reluctant to try new technologies in this area, due to the lack of suppliers and technical knowledge. If a problem is encountered in the system, neither assistance nor maintenance services are available.

To register, the previous bad experiences of some technologies implemented in the Region some years ago, became an obstacles too, for the development of this kind of projects, mainly solar thermal.

During the development of the project, AREAM had to play the role of the potential supplier, because of the absence of them in the region, and the suppliers did not show interest in this action.

Another important obstacle is the cost of the system, which is highly increased, adding the transportation cost to Madeira island.

6.2.5. Impact assessment in Sicily, Italy

As monitoring of 40 technical visits carried out at hotel structures in Sicily, a series of features relating to the quantitative and qualitative impressions of these with respect to the possibility of the use of RES systems in the hotels of the region have been evaluated.

Sicily is the largest island in the Mediterranean (25.700 km^2), over 5.000.000 inhabitants; 15 small islands around the coast; located between 38.5° and 37.0° N. Lat., 25% of mountain territory; mild climate (26 °C average in summer, 12 °C average in winter); 8 millions toe of energy demand in year 2000; solar potential: 1.650 kWh/m^2 per year, equivalent, from energy point of view, to 170 l of oil; the regional energy demand is equivalent to the solar energy falling on 50 km^2 area (0.2% of the territory).

AMG has focused its activity within HOTRES project on the solar technologies.

Actually the members of the hotel sector showed a greater interest for active solar systems, especially solar thermal for hot sanitary water and medium power solar photovoltaic grid connected.

(i) Positive impact assessment for the Italian tourism sector

The main positive points in opinion of the stakeholders of the sector interviewed are shown, relating with the application of solar energy systems in hotel establishments in Sicily.

The good results of the monitoring of energy performance of solar thermal installations in hotels, confirmed that, the cost benefit analysis can be very effective (solar factor—percentage of the consumption covered by solar energy—more than 65% and relative pay back time less than 8 years, without any public support, respect to an average life of the solar facilities of at least 15 years).

The diffusion of these results during the technical visits and the business meetings has contributed to overcome the common distrust respect to the application of RES.

To avoid distrust, it is important also to guarantee a high quality of installation, management and maintenance and to disseminate the existing local best practices.

Among other positive aspects, it was emphasized by the hotels contacted, the saving in fuel consumption and in consequence, the economic saving, that is possible to obtain from the installation of these systems. The distribution of the folder, produced for this project, and the meetings held between AMG and the hotel managers, contributed greatly to enhance the idea of the 'green' image and social awareness image of the enterprises to the general public and possibly to increase their market value.

More over, they have informed the hotel managers, how these technologies could aid them in introducing environmental management schemes, where energy and money can be saved and avoid pollution simultaneously.

The existence at regional (*Structural Funds*, *Objective 1 Region*) and national level (*10.000 PV Roofs Programme, Solar Thermal Programme—Ministry of Environment*) of subsidies for the installation of solar thermal systems of hot sanitary water and photovoltaics, both stand-alone as well as connected to the grid, that reduces the initial investment of the installation of these systems. It should also be indicated that some hotels have received a type of subsidy, complained about the long and complex procedures that they had to go through in order to obtain subsidy funds.

The hotel manager gives generally a great importance to the environmental image; in specific, from those, who their clients are looking for of an ecological tourism. In any case, a huge part of tourism in Sicily comes from central and northern Europe where there is greater awareness of the environment. In this sense, the hotel establishments that use RES are favored by this tourism.

In rural type lodgings, located in natural spaces away from conventional energy sources, it is positively valued the autonomy, from the energy point of view, that these types of installations offer, the energy saving that is introduced in transport and fuel consumption and the ecological image in accordance with the philosophy of tourism that goes to these natural spaces.

(ii) Negative impact assessment for the Italian tourism sector

The main obstacles noticed to the implementation and use of RES in the hotel sector, are the following.

The high initial investment that is needed, for undertaking the equipping of this type of installation; it seems, however, that it is smoothed by the public subsidies available at regional and national level. Another important obstacle is in the organizational structure of

the hotel sector in Sicily; many of the hotel establishments of our region belong to great chains of trans national or multinational character or the managers of these hotels have deprivation of powers to undertake, independently, the investments in RES. Specifically, 25% of the hotels surveyed belong to hotel chains.

Sometimes the architectural integration and the possible visual impact constitute the installation of active solar impossible. Some of the hotels visited are located in historical areas of cities and sometimes even the hotels are historical buildings and, therefore, have to adapt to the regulation requirements that make the installation of solar collectors, thermal or photovoltaic, difficult.

The wish to invest in the RES is weak but needs to be developed through information campaigns.

7. Validation of the HOTRES methodology and perspectives

7.1. Validation of the methodology

Taking into consideration the above analytical conclusions and the specific market aspects of the hotel sector in each region, we are able to validate the applied scheme of promotion methodology, which has been centered on the following five key-directions.

(i) The partnerships

Five RET have been promoted. Wind and hydraulic energy, since it gives often grid-connected systems, are not included in the project; the numbers of potential investors in the hotel sector are rather weak. The following RET have been included and have been assessed by the respective EU level Manufacturing Association:

- Solar thermal (ESIF—European Solar Industry federation).
- Geothermal (EGEC—European Geothermal; Energy Council).
- Solar PV (EPIA—European Photovoltaic Industry Association).
- Biomass (EUBIA—European Biomass Industry Association).
- Solar passive.

It has been proved that Solar Thermal and Geothermal energy are the strong candidates for future expansions in the hotel sector. Solar PV energy is rather important, while biomass energy presents a poor profile.

It is very surprising that Solar Passive energy, which should be the strongest product to penetrate the hotel market, is very low in inquiries, despite the strong promotion during events.

(ii) The regional and sectorial approach

In the past, national actions offered important statistic results; but they could not implement conditions for the expansion of the technologies. The regional approach is compatible with the hotelier psychology: 'he will install geothermal since the competitor in the region has put it'. The hotel sector must be addressed within sectional studies in order to allow to the MAs (Manufacturers Associations) to pursue sector product needs and enlarging the market in order to proceed in the future with new product designs.

The regional approach, offering the technical support to hoteliers has been proved very useful and crucial key-direction due the positive impact of the competition between hoteliers.

(iii) Business orientation, promotion of commercialized products

Due to the involvement of MAs in these projects, oriented business achievement has been made, helping the campaign to spread out and be successful.

The promotion of commercialised products in the hotel units has been also a successful key-direction, since the hoteliers showed a particular interest in inspecting and visiting existing installations under operation.

(iv) Third party information

Very often, in the past, the hotel sector received quotations and feasibility studies, RET related, with non-compatible information or even with misleading or defaming information against other competent RET or conventional technologies. Therefore there is a strong need for a third party independent information in order to enlarge markets. This independent role has been supported by the involvement of the Energy Agencies (CRES, ADEME, SODEAN, AMG and AREAM).

We estimate that this key-direction of the HOTRES project has consisted its strongest point for having achieved an effective promotion.

(v) Show the viability of the technologies

In order to overcome the doubtfully of the hoteliers–investors regarding the RET, their viability, their feasibility, how easy is to use, their satisfactory level of maintenance needs and related energy performance must be documented. Therefore there is need for monitoring of the existing installations. This role has been supported by the promotion centers and by regional agencies, carried out in eight hotel units.

The documentation of the above-mentioned monitorings has been a valuable tool for justification into the technico-economic analysis of 50 prefeasibility studies carried out in the project.

7.2. Perspectives

The HOTRES project focused at devising and implementing the strategic methodology for the promotion of RET. The core aspect of this methodology has been the concentration on the implementation of conditions for the future expansion of these technologies in the hotel sector. This has been done mainly by business oriented on a regional level, by agencies with equipment MAs.

The action plan of the HOTRES project aimed at the hotel sector; in future it must apply to a larger amount of countries, or to different form of establishments (i.e. mountain hotel units) and different climate regions (i.e. Northern European).

It has been emerged from the conclusions of the HOTRES project that future projects must foresight at:

TARGET GROUP 1b, RUE (Rational Use of Energy) and ES (Energy Saving) technologies in the hotel sector.

TARGET GROUP 2, must aim at the second target group of companies with tourism activities, (catering, leisure, museums, entertainment, etc), promoting both RETs, and RUE/ES technologies.

TARGET GROUP 3, must aim at a third target group of companies—suppliers to which we must promote both RES and RUE/ES technologies. This important of the third target group companies is the whole chain of SMEs which act as suppliers to the tourism industry, such as:

- Spa and water services suppliers or manufacturers,
- Laundry equipment manufacturers,
- HVAC equipment manufacturers,
- Lighting and internal decoration SMEs,
- others.

8. Conclusions

The results of the actions pursued by the consortium, following this HOTRES project, have been plenty, such as the exchange of information, the network effects, the possibilities for trans-European and international collaboration, the installation of permanent information infrastructure, the elaboration of co-operation meetings inside workshops.

As type of actions we created 5 workshops, related to 5 regional campaigns, we have edit a brochure in 2000 copies per language (5 national languages), 200 door to door meetings, application of 50 executive preliminary diagnostic designs, elaboration of 8 monitoring to existing installation of RETs inside hotel units, 25 at the point visits and application of 6 basic designs.

Following the above rich action plan, actual market actors met with regional hoteliers and their business operators. We expect in future, as a follow up, applications of the RET in the regional hotel sector and, in medium term, local manufacturing of RES products after a know-how transfer phase or trade agreement that will obviously create labour development and in the long term a general economic local development.

It has been considered that the best way to present the efficiency of the HOTRES project is to display them within three axes:

- Results attainted in a quantitative basis, especially related to technical and economic issues
- Impact assessment of the HOTRES project, positive or negative (obstacles)
- Validation of the HOTRES methodology and perspectives.

The quantitative conclusions from the technical and economic issues are related to the volume of the relevant market, the average size of the equipment, the type of the RET applied in 50 hotel units and last the estimated pay back period of the investment.

These quantitative results attain are:

- Fifty hotel units with no RET application in the 5 targeted regions have been addressed with a menu of ten products related to five RET technologies (PV unit grid connected,

solar thermal cooling, solar Domestic Hot Water (DHW), solar heating of swimming pools, olive cores burner for space heating, geothermal heat pumps, direct geothermal space heating, planted roofs, atriums for artificial lightning and solar thermosiphonic systems with panels)

- PV unit grid is more common in Italy and Spain, where the specific promotion result has been proved more effective
- The market reaction has been friendly to three of the five RET under promotion with the following shares: 66% to solar thermal (including solar cooling), 10% geothermal (uniquely geothermal heat pumps) and 24% to PV units grid connected, Fig. 5)
- The RETs examined in these 50 case studies have showed an interesting level of cost effectiveness. This effect is highly important when subsidies of local governments are taken in account. The shortest pay back period refers to the solar thermal. For the three RETs in question we achieved the following results:
- for the solar thermal it varies from 1.7 years in Greece up to 19 years in France
- for the solar PV it varies from 6 years in Spain up to 43 years in Greece
- for the geothermal heat pump it varies from 3.9 years up to 4.7 years in Greece
- the cost of solar thermal systems vary from 320 € in Greece up to 800 € in France and this variation can explain the relevant variations in the respective payback periods (it is impressive to notice that solar thermal in France displays electricity, which is extremely cheap).

Secondly, the conclusions from the impact assessment are related to the objectives of the HOTRES project, by taking into consideration the relevant market audits, events, monitoring results of existing RES installations in the hotel sector and general information from the 5 regions involved in the elaboration of the scheduled work.

These qualitative results attain are:

- the tourism sector apply yearly, important investment programmes under the code name 'renovation works' and it is beneficial to relate the RETs to this code name, since the RETs offer to the enterprise an ecological image, often necessary to the hotel manager in order to compete with the upcoming and severe standards for environmental protection
- hotels are energy consuming enterprises and this is why RETs can be a viable solution in reducing energy consumption and energy cost; they can also promote local production of technologies (i.e. solar) and the general local development
- the strategic methodology of the project HOTRES seems to have a positive impact to the hotel managers, because the technologies under promotion are already demonstrated, in commercial scale and, most important, in already operating hotels of their neighborhoods or in their 'competitors'
- even if we meet a poor specimen of application with RES, locally, while in other sectors RES perform a rich expansion experience (i.e. building sector), we have localized numerous hotel units with very satisfactory, energy related, operation
- there is great need for the announcement of subsidy programmes, from the Local Authorities, which overall act as psychological incentive.

Finally, the conclusions from the validation of the applied methodology are related to the partnership scheme, to the sectorial approach, to the regional approach, to the business orientation, to the third party orientation, to the measurement of the viability and the cost effectiveness of the RETs and to the design of the perspectives.

These validation results attain are:

1. As far as partnership concerned, it has been proved that the hotel sector needs agencies to implement RET projects and Manufacturing Associations to supply reliable technical information.
2. Concerning the approach by the sectors, it has been proved that hoteliers are motivated to invest when other hotel managers do it first.
3. As far as regional approach is concerned, it has been proved that hoteliers are motivated to invest by visiting applications of RET in other locally placed hotels, mostly competitors.
4. Concerning business orientation hoteliers need commercialized solutions, they do not accept easily 'new technology' projects.
5. As far as third party orientation, hoteliers highly appreciated the fact that the HOTRES project supplied them with technical information, with no extra cost and effort.
6. Concerning the viability and the cost effectiveness of the equipment, the hotel actors visited 25 existing installations in other hotels and have been supplied with 50 pre-diagnostic studies suggesting RET equipment with reasonable pay back period, often competitive to conventional sources. This last has been particularly true for the solar thermal water heating in hotels.

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Appendix. Case study: the largest solar thermal application in hotels in the EU

a. *Aldemar (Royal Mare, Cretan Village, Knossos Royal Village).*

Hotel details.

Location:	Crete
Geography:	Beach
Class:	De luxe
Clients activity:	Tourist
Number of beds:	2300

Operational season:	Full
Built area:	2.783 m^2
Name of contractor:	Sol energy
Year of erection:	2000

b. *Investment features*

Installation of a solar system, including 2.783 m^2 of collector field for hot waters production and 150 m^3 hot water reservoirs (Figs. 6 and 7).

Upgrade of all mechanical equipment and a number of changes in order to maximize the annually energy savings.

Heating of seawater in order to use it for the spa center.

Reservation of energy performance and protection of mechanical equipment against corrosion.

Central Building Energy Management System (BEMS) with energy management applications, programmable controller, monitoring station. BEMS measures and keeps historic data of power consumption and manages energy conservation.

c. *Energy requirements before/after investment.*

Target thermal energy annually requirements (LPG, Diesel)	3.57/4.484 MWh diesel, LPG
Energy produced annually (audits)	1.322 MWh/year
Fuel saving annually	29%
Energy performance annually (audits)	480 kWh/m^2/year



Fig. 6. View of Aldemar hotel complex.



Fig. 7. Flat plate collectors' central solar system.

d. *Investment financial features–benefits*.

Investment budget	1.212 M€
Operational Programme for Energy (OPE) has subsidized the project:	Subsidy 50%
Estimated payback period	4.1 years (tanking into account the subsidization)

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